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URBAN CAT POPULATIONS COMPARED BY SEASON, SUBHABITAT AND SUPPLEMENTAL FEEDING

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SUMMARY

(1) Population densities of free-ranging cats were compared in two contiguous urban subhabitats, in three seasons, and in response to supplemental feeding.

(2) One subhabitat, characterized by voluminous, poorly contained refuse, and many abandoned buildings, supported $4{\cdot}88 \pm 0{\cdot}82$ cats ha^{-1} (mean $\pm$ S.D.), which differed significantly from the $2{\cdot}03 \pm 0{\cdot}2$ cats ha^{-1} supported by the other subhabitat (partial refuse containment, few abandoned buildings).

(3) Neither season nor supplemental feeding had a significant effect on population density.

(4) The distribution of individuals within the study area varied with the availability of shelter and was not dependent upon food.

INTRODUCTION

Free-ranging cats in urban areas are not truly pets, nor are they truly feral. The works of Leyhausen (1979), Dards (1978, 1981), Oppenheimer (1980), Tabor (1981) and Childs (1986) have begun to explore the ecology of these animals, but none of these studies has involved the continuous observation of tagged cats. This study compares population size differences of marked free-ranging urban cats with regard to season and subhabitat. In addition, it examines the effect on population size of experimental supplemental feeding, an acknowledged primary food source (Dards 1981; Tabor 1981).

METHODS

The study area encompassed two contiguous yet distinct residential neighbourhoods in Brooklyn, New York. Sector A (16·44 ha) was characterized by rental apartment buildings, many abandoned structures and voluminous refuse in uncovered receptacles. Sector B (16·75 ha), in contrast, was composed of owner-occupied private houses where refuse containers were often covered. There were few abandoned buildings in sector B.

The cats studied were free-ranging adults, i.e. males of 3·00 kg or more, females of 2·25 kg or more. In Brooklyn pet cats usually wear collars. For this study, free-ranging cats included all animals which were not identified as pets. To further avoid including pets, a letter in English and French was distributed to all residents requesting that pets not be allowed to roam.

The experimental design was based on a 1-year pilot study which entailed live-trapping, marking and subsequent surveying of the population. The cats were most active between

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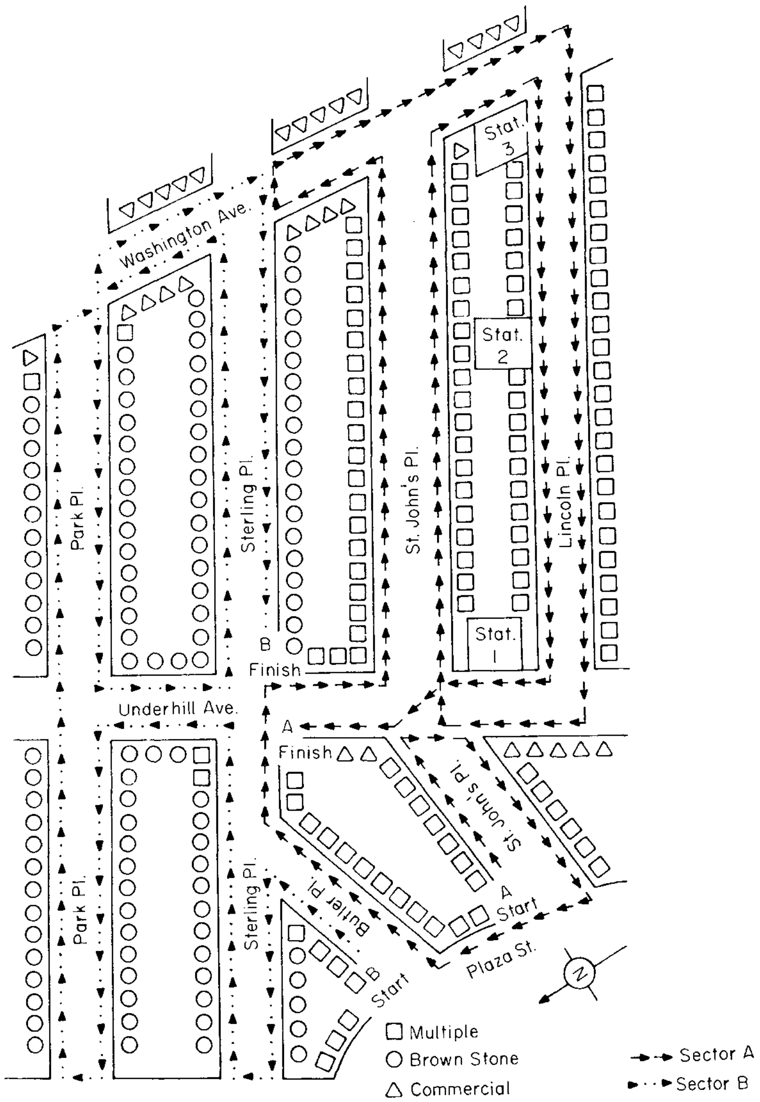

FIG. 1. Map of the study area showing the distribution of housing, location of feeding stations, and the transects used to patrol in sectors A and B.

22.00 and 07.00 hours. At the start of each of three seasons (autumn 1981, spring 1982 and autumn 1982), cats were live-trapped for marking on thirty consecutive nights. Three modified Havahart traps equipped with signal lights (see Haspel & Whitman 1981) and baited with canned cat food were deployed on each block face of the study area. Traps were monitored until no unmarked cats were caught in any one night. Cats were marked with individually colour-coded collars fashioned from hospital identification bracelets. Coloured collars contrasted with the cat's fur and could be recognized from a distance of 25 m.

Following each trapping period, the cats were sampled over 60 days by patrolling a transect through the study area (see Liberg 1982 and Fig 1). With the observer looking forward, all cats, marked and unmarked, sighted between the centre of the street and the building line were recorded for identity, location, time and activity. The hours between 22.00 and 07.00 were divided into three 3-h time blocks, and three patrols of one sector were completed in one time block. Time blocks and sectors were randomized so that six nights were required to complete one iteration of the experiment. Ten iterations were accomplished in each of the three 60-day observation periods, which began on 9 September (autumn) and 1 April (spring) so that day–night lengths would be comparable.

Population size was estimated using the triple capture–mark–recapture (CMR) method developed independently by Jolly (1965) and Seber (1965), and amplified by Tanner (1978). The population model is stochastic and the calculations do not require that captures be made at regular intervals. Meristic variables were analysed using the log-likelihood ratio statistic which is distributed as chi-squared.

The effect of experimental food supplementation was measured by establishing three feeding stations in sector A only; observations in sector B and in the previous two seasons served as controls. Autumn is a peak period of pregnancy and lactation. From 28 July until 7 December 1982, a mixture of 1·1 kg of Kal Kan cat food and 340 g of Purina Cat Chow was distributed each night in three portions to each of three feeding stations which were located where no cats were observed in the previous seasons (Fig. 1). Following recommendations in Fitzgerald (1980) and Collier *et al.* (1978), it was estimated that these rations would fully support from twelve to thirty cats.

RESULTS

Trappability

The mean trappability (77·2%) is sufficiently large that estimates of population size are expected to have less than 5% error attributable to non-random sampling (Hilborn, Redfield & Krebs 1976). Trappability of both sexes was determined from records of cats trapped and subsequently sighted (recaptured) more than once (Table 1). Recapture by sighting cats differs from grid-trapping recapture data in that the accuracy of the former is unaffected by population density, thus our estimates of trappability appear to be high compared to those, for example, of live-trapped voles (Krebs 1966). Mean trappability of males was higher than females ($P < 0{\cdot}05$). There is no difference in trappability between sectors or among seasons ($P > 0{\cdot}20$).

Seventy-four per cent of all collared cats were recaptured at least twice. The mean number of recaptures was 8·0 out of a possible 10 repetitions. There were no significant differences between the means for sexes, sectors or seasons ($P > 0{\cdot}20$); that is, all categories of cats were equally accessible to sighting (recapture) throughout the experiment.

Population sizes and distribution

The mean ($\pm$S.D.) population size of sector A ($80{\cdot}3 \pm 6{\cdot}9$) was more than twice that of sector B ($34{\cdot}1 \pm 1{\cdot}7$ cats ($P \leqslant 0{\cdot}01$); Table 2) The average ($\pm$S.D.) population densities were $4{\cdot}88 \pm 0{\cdot}81$ and $2{\cdot}03 \pm 0{\cdot}20$ cats ha,$^{-1}$ respectively. There was no significant difference in the number of cats among the three seasons, and seasons and sectors are independent ($P > 0{\cdot}20$, Table 2). The population consists of apparently solitary individuals and females with offspring. Experimental supplemental feeding in sector A (autumn 1982) had no perceptable effect on population size, although the number of cats sighted at the feeding stations was greater than in the autumn of 1981 ($P \leqslant 0{\cdot}05$). Where

TABLE 1. Trappability is expressed as the unweighted percentage of collared cats which were subsequently sighted at least once. The mean number of iterations ($\pm$S.D.) until a marked animal disappeared from the study area refers to cats trapped and sighted at least twice and has a maximum value of 10

	Autumn 1981	Spring 1982	Autumn 1982	Means
Trappability				
Sex				
Male	68·8	86·3	86·4	81·4
Female	73·6	69·0	73·7	72·4
Sector				
A	72·6	77·4	80·2	76·7
B	71·7	84·8	77·2	77·9
Means	72·3	79·1	79·5	77·2
Repetitions until a marked animal disappeared from the study area				
Sex				
Male	8·5$\pm$2·0	7·9$\pm$2·3	7·7$\pm$3·0	8·0$\pm$2·5
Female	8·3$\pm$2·7	8·8$\pm$2·2	7·2$\pm$3·1	8·0$\pm$2·8
Sector				
A	8·6$\pm$2·4	8·5$\pm$2·3	7·8$\pm$2·8	8·2$\pm$2·5
B	7·8$\pm$2·7	7·6$\pm$2·3	6·5$\pm$3·7	7·1$\pm$3·1
Means	8·4$\pm$2·4	8·4$\pm$2·3	7·5$\pm$3·0	8·0$\pm$2·6

TABLE 2. Estimated population sizes based on triple capture–mark–recapture data are given with 95% confidence intervals. The number of male and female cats trapped and collared are presented by study period

	Autumn 1981	Spring 1982	Autumn 1982
Estimated population sizes			
Sector			
A (rental apartments)	96·25$\pm$16·24	63·15$\pm$12·81	81·54$\pm$12·95
B (private houses)	29·59$\pm$23·97	35·19$\pm$25·99	37·48$\pm$9·35
Number of cats collared			
A-males	19	22	28
A-females	19	20	26
B-males	8	9	10
B-females	9	4	8

shelter was also available at Station 2, the number of cats increased from September to November (Fig. 2).

Resource availability

The availability of open refuse containers in sector A was 2·1 times that in sector B ($P \leqslant 0·01$; Table 3). However, from estimates of food waste in New York City (Brunner 1984), it was calculated that refuse provided approximately $3·57 \times 10^6$ J cat^{-1} day^{-1} in sector A and $3·97 \times 10^6$ J cat^{-1} day^{-1} in sector B. In both sectors this is more than three

TABLE 3. Differences in availability of food and shelter between sectors A and B were estimated by gross measurement of refuse and abandoned buildings. The human populations were homogeneous for all measured variables

	Sector A	Sector B	G	d.f.
Refuse				
Total open containers	17 564	8330	3366·00**	1
Abandoned buildings				
Number of buildings	14	6	3·29 N.S.	1
Buildings × height in stories	62	20	22·56**	1
Types of housing				
Private houses	7	37	35·89**	1
Rented apartments	78	38		
Human residents				
Black:white:other	31:15:33	34:17:16	5·03 N.S. (a)	2
White:other	15:64	17:50	0·53 N.S. (a)	1
Duration of residence of humans in study area				
< 1 year	8	5	0·93 N.S. (a)	3
2–5 years	27	22		
6–10 years	22	18		
> 10 years	35	36		

(a) Information gathered by telephone survey of study area residents.
G is distributed as chi-squared. $^{**}P \leqslant 0{\cdot}01$.

times the cat's average daily energy requirement ($9{\cdot}67 \times 10^5$ J day^{-1}; Anon. 1982). There was more floor space in sector A than sector B ($P \leqslant 0{\cdot}01$); the number of floors in abandoned buildings was three times greater in sector A. The human populations, 5294 persons in sector A and 2532 in sector B (Anon. 1983), were similar both in ethnic background and duration of residence ($P > 0{\cdot}20$).

In conjunction with this project, the authors conducted a telephone survey of the human residents within the study area. Of 270 households contacted 177, distributed approximately equally between sectors A and B, agreed to participate. Five residents in this sample admitted to feeding cats daily, four in sector B and one in sector A. On average the five daily feeders provided 1·47 kg of cat food day,$^{-1}$ and four of the five said they also

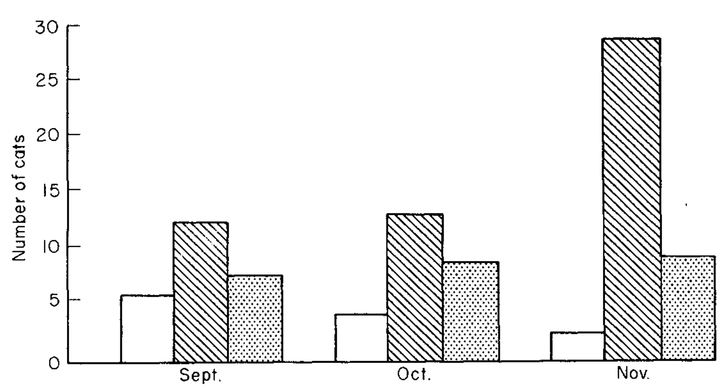

FIG. 2. The number of uniquely marked cats sighted at stations 1 (□), 2 (▧) and 3 (▤) in Brooklyn, New York, during autumn 1982.

TABLE 4. Mean live weight (±S.D.) in kg of cats trapped in Brooklyn, New York

	Autumn 1981	Spring 1982	Autumn 1982	Means
Sex				
Male	3·9±0·9	4·3±0·7	4·0±0·7	4·1±0·8
Female	3·0±0·6	3·2±0·6	2·4±0·4	2·9±0·6
Means	3·4±0·8	3·8±0·6	3·4±0·6	3·5±0·7

provided shelter. If these numbers are representative of the 2563 households in the study area (Anon. 1983), at least four households provide daily rations to cats on every street in the study area, with perhaps a higher concentration in sector B. In addition to the five feeders discovered by telephone survey, ten other daily feeders were encountered, four in sector A and six in sector B.

Body weight of male cats averaged (±S.D.) 4·1±0·8 kg and of females 2·9±0·6 (Table 4). These figures compare favourably to those for crossbred pets: males average 4·7 kg and females 2·6 kg (Scott 1976).

DISCUSSION

The cat population in the study area is stable and comparable in density to other urban areas. Dards (1981) reported urban cat densities in Portsmouth Dockyard, England, of two cats ha^{-1} while Oppenheimer (1980) observed a range of 1·51–7·43 cats ha^{-1} in Baltimore, Maryland, depending on which neighbourhood she examined. Estimates for rural areas are much lower; Van Aarde (1978) found 0·35 cats ha^{-1} for cats on Marion Island, while Hubbs (1951) reported 0·12 cats ha^{-1} in rural Sacramento Valley. Warner (1985) working in rural Illinois found 0·063 cats ha^{-1} and Liberg (1980) observed 0·025–0·033 cats ha^{-1} in southern Sweden.

Although our results agree favourably with observations on other urban cat populations, they are probably a minimum estimate of the true population size. Mares, Streiban & Wilig (1981) compared three commonly used CMR techniques and found that they did not get accurate estimates of a population of Eastern chipmunks, *Tamias striatus*, until at least 75% of the animals had been recaptured. Either the estimates were significantly too small or confidence intervals were too large. When we estimated populations using the triple CMR technique, only 66·6% (autumn 1981), 35·8% (spring 1982) and 70·1% (autumn 1982) of the marked individuals had been recaptured by the second recapture. These low percentages of recapture account, in part, for the large confidence intervals on our population estimates.

The difference between urban and rural cat densities has been attributed to the plentiful food in the urban environment. Both Dards (1981) and Tabor (1981) believe that supplemental feeding by humans is the primary factor accounting for large cat populations in urban England. However, food availability does not account for the distribution of cats between sectors A and B. The cat populations in the two sectors are not proportional to the volume of available refuse ($P<0·05$); there is a significant excess of open refuse containers in the area of private housing, sector B. Furthermore, our estimate of the number of daily cat feeders indicates a 2:1 ratio in favour of sector B. For most of the year, the energy available in refuse exceeds the cat's nutritional needs, and the presence of daily feeders further inflates the excess of food, especially in sector B. We estimate that the quantity of food provided by feeders is sufficient to support 4·2–5·2 cats ha.$^{-1}$ Our attempted supplemental feeding in sector A had no measurable effect on cat density, but only brought about a redistribution of animals within the sector. In this environment cats are seldom predators. Although birds and small rodents are plentiful in the study area, only once in more than 180 h of observations did we observe predation. The live weight of trapped cats was indistinguishable from expected values for pets. Food is abundant in this urban site and is not a limiting factor for the cat population.

Shelter appears to limit the number of cats which an urban environment can support. These neighbourhoods are generally hostile to cats; free-ranging cats avoid most humans by seeking shelter in abandoned buildings and emerge only late at night. The estimated number of cats in sectors A and B is directly proportional to the number of floors in abandoned buildings. Assuming internal staircases allow free access to cats once inside an abandoned building, differences in building size more accurately reflect available space; cats were observed entering and leaving these buildings. Feeding station 1 was adjacent to an apartment building with broken basement windows. The number of cats observed there increased until the building superintendent boarded up the windows, then the number of cats declined to their previous level. At station 2 the number of cats feeding continued to increase, and the cats were observed to take shelter in nearby buildings. Several daily feeders in sector B built cat shelters adjacent to their homes, but the interior of occupied buildings was inaccessible to cats. The distribution of animals between sectors may have been governed, in part, by the degree to which humans limited access to shelter.

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